Swansea University
Prifysgol Abertawe

$$\mathrm{Re} = \frac{\rho V L}{\mu}$$

$$\mathrm{St} = \frac{f L}{V}$$

EGF320 - Fluid Flow

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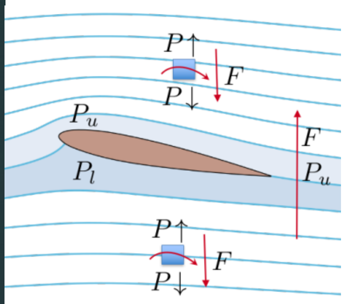

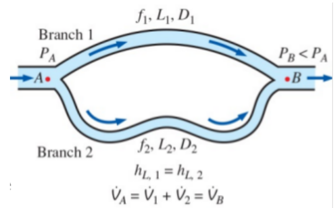

Module Synopsis

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(1) Dimensional analysis and modelling

- Analysis of relationship between physical quantities

(2) Internal flows

- Flow through pipes and piping networks
- Flow rate and velocity measurement

(3) External flows

- Prediction of lift and drag for flows over common geometries

(4) Fluid kinematics and differential analysis of fluid flow

- Fluid velocity fields, Streamlines, Pathlines etc.

Learning Outcomes

After completing this module you should be able to demonstrate a knowledge and understanding of:

- Dimensional analysis
- Flow through pipes and piping systems
- Flow rates and velocity measurement techniques
- Drag and lift coefficients; flow over flat plates, cylinders and spheres.
- Lagrangian and Eulerian descriptions of flow and the Reynolds Transport theorem

Reading List

1.) Fluid Mechanics: Fundamentals and Applications,
by Yunus A. Cengel and John M. Cimbala.

2.) Fluid Mechanics,
by John F. Douglas, Janusz M. Gasiorek, John A. Swaffield, Lynne B. Jack

Module Delivery

- Four 3-4 hour lectures; **every other Wednesday**
- Theory followed by worked examples
- Tutorial problems
- Lecture notes will be placed on Blackboard and my personal website.
- Past exam papers will be placed on Blackboard at appropriate times

Teaching Plan

Week 1 – Dimensional Analysis

Week 2 – Internal Flows

– Class Test

Week 3 – External Flows

Week 4 – Fluid Kinematics

– Summary and Revision

Module Assessment

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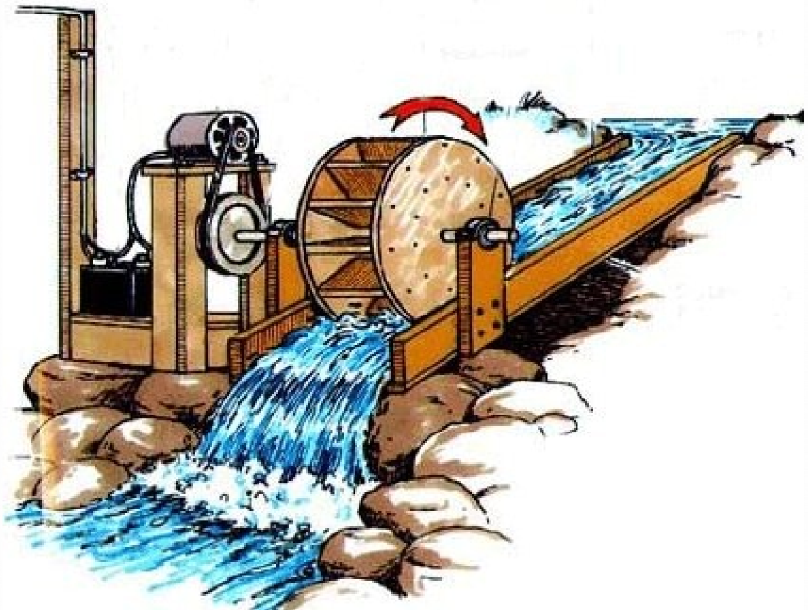
Examination

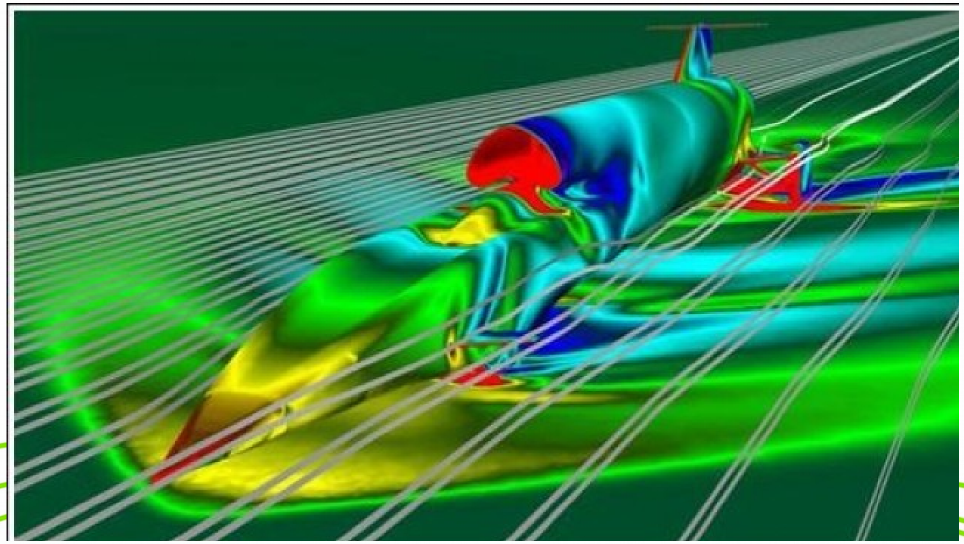
- Open book examination
- Data/Formula sheet will be provided
- Class Test - 30%
- Final Exam - 70%

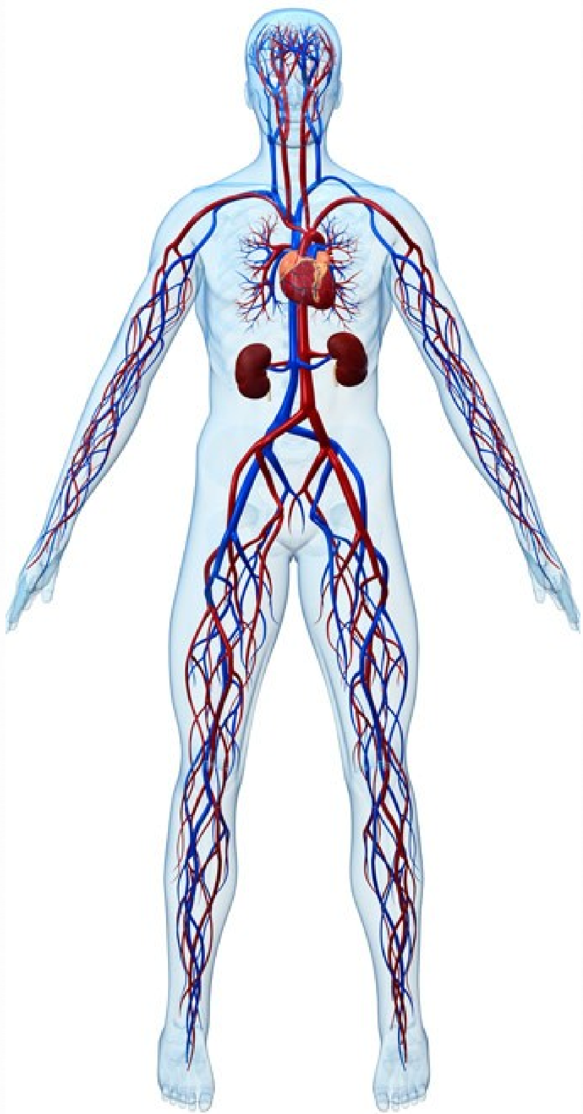
Note: The College of Engineering has a ZERO TOLERANCE penalty policy for late submission of all coursework

Fluid Flow - Introduction



www.pumpfundamentals.com





Asme.org

Fluid Flow - Basics

- States of matter
  - Solid, Liquid, Gas, Plasma, Bose-Einstein condensate
- Liquids and gases can be grouped together as fluids.
- Fluids flow under the action of external forces, deforming continuously, for as long as the force is applied.
- Fluid takes the shape of any solid body with which it comes into contact.
- In fluids, the deformation is caused by shearing forces.

A fluid is a substance which deforms continuously under the action of shearing forces, however small they may be.

Fluid Flow - stresses

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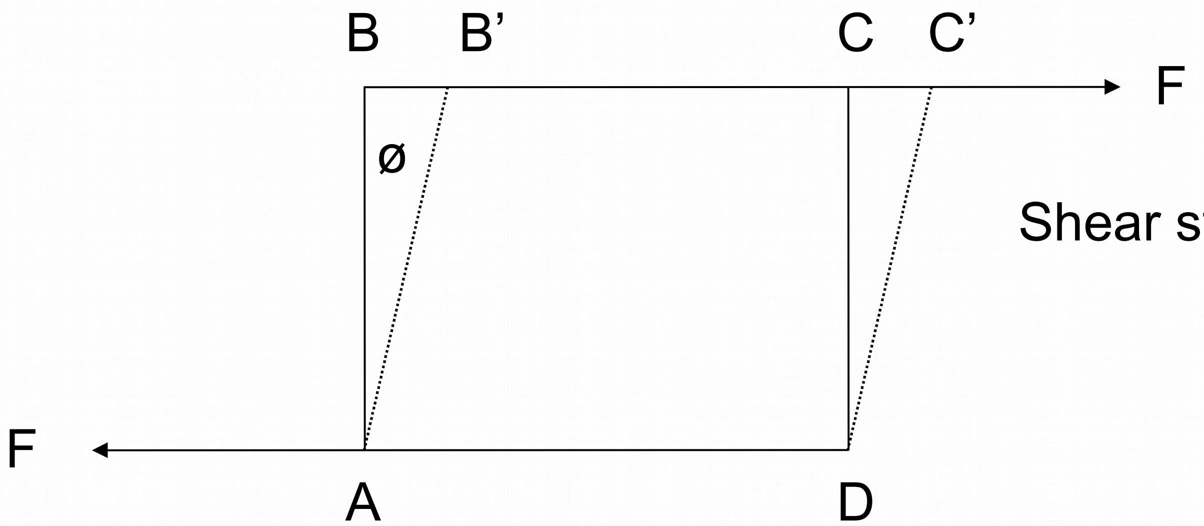

Shear strain, $ø = x/y$

Rate of shear strain, $x/y/t = (x/t)y = u/y$

Shear stress, $\tau = \mu\, du/dy$

μ is the coefficient of dynamic viscosity

For a solid, the stress is a function of strain (in the elastic limite).
For a fluid, the stress is a function of rate of strain.

Fluid Flow - Basics

Fluid Flow

Fluid Statics
Fluids at rest

Fluid Dynamics
Fluids in motion

Fluid Flow - Basics

Uniform flow: velocity at a given instant is the same in magnitude and direction at every point in the domain.

Non-uniform flow: velocity changes from point to point.

Steady flow: velocity at a point does not change with time.

Unsteady flow: velocity at a point changes with time.

Steady uniform flow

Steady non-uniform flow

Unsteady uniform flow

Unsteady non-uniform flow

Fluid Flow - Basics

1. *Steady uniform flow.* Conditions do not change with position or time. The velocity and cross-sectional area of the stream of fluid are the same at each cross-section: for example, flow of a liquid through a pipe of uniform bore running completely full at constant velocity.
2. *Steady non-uniform flow.* Conditions change from point to point but not with time. The velocity and cross-sectional area of the stream may vary from cross-section to cross-section, but, for each cross-section, they will not vary with time: for example, flow of a liquid at a constant rate through a tapering pipe running completely full.
3. *Unsteady uniform flow.* At a given instant of time the velocity at every point is the same, but this velocity will change with time: for example, accelerating flow of a liquid through a pipe of uniform bore running full, such as would occur when a pump is started up.
4. *Unsteady non-uniform flow.* The cross-sectional area and velocity vary from point to point and also change with time: for example, a wave travelling along a channel.

Fluid Flow - Basics

Energy equation